PROJECT DATA

PureVision Technology, Inc. - 02GO12059

Completing Pre-Pilot Tasks To Scale Up Biomass Fractionation Pretreatment Apparatus from Batch to Continuous Process

Recipient:	PureVision Technology, Inc.	Instrument Number:	DE-FG36-02GO12059
Recipient Project Director:	Ed Lehrburger 303.322.4555 511 N. McKinley Ave. Ft. Lupton, CO 80621	CPS Number:	1831
		HQ Program Manager:	Lisa Barnett 202.586.2212
		GO Project Officer:	Andy Trenka 303.275.4745
Recipient Type:	For Profit Organization	GO Contract Specialist:	Melissa Wise 303.275.4907
Subcontractor(s):		B&R Number(s):	ED190602
		PES Number(s):	02-2140, 03-11015
EERE Program:	Biomass	State Congressional District	CO - 4

PROJECT SCOPE: The objective of this project is to produce sugars, fuel, energy and specialty chemicals from waste biomass at costs competitive with petroleum. The project will produce a wash liquor stream containing primarily water and hemi-sugars, a stream containing primarily water and lignin, and a third purified cellulose product stream. Costing and design criteria will be used to build a skid-mounted 1 ton per day pretreatment pilot plant. The expected savings per facility are 0.4 million bbls of oil per year (roughly 16 million gallons of ethanol/year, equivalent to 400,000 barrels of oil). Biomass contains little sulfur and nitrogen, thus minimizing SO_2 and NOx emissions.

FINANCIAL ASSISTANCE

Approved DOE Budget	$200,000	Approved DOE Share	$200,000
Obligated DOE Funds	$200,000	Cost Share	$33,799
Remaining Obligation	$0		
Unpaid Balance	$46,544	**TOTAL PROJECT**	**$233,799**

Project Period: 8/19/02-6/30/04

TECHNICAL PERFORMANCE

DE-FG36-02GO12059

PureVision Technology, Inc.

Completing Pre-Pilot Tasks to Scale Up Biomass Fractionation Pretreatment Apparatus from Batch to Continuous Process

PROJECT SYNOPSIS

The overall goal of the PureVision approach is to produce sugars, fuel, energy and specialty chemicals from waste biomass at costs competitive with petroleum. In order to enhance and extend the dome, PureVision has developed a biomass conversion technology that separates ligno-cellulosic materials into product streams for economical processing into energy and industrial products. The proposed work will advance the PureVision commercialization efforts by completing essential equipment evaluations for scaling up an invention currently undergoing testing that, to date, has proven to work only at batch processing. Coperion will be contracted to use their equipment and pilot plant to test and collect data on retrofitted equipment. PureVision will demonstrate the ability to process corn stover into three fractions. The first is anticipated to be a wash liquor stream containing primarily water and hemi-sugars. The second is anticipated to be a wash liquor stream containing primarily water and lignin. The third is expected to be a purified cellulose product stream. By the conclusion of this assessment, PureVision expects to have all the costing and design criteria to build a skid-mounted 1 ton per day pretreatment pilot plant.

The new method is expected to save an estimated 0.4 million bbls of oil per year per facility (roughly 16 million gallons of ethanol/year, equivalent to 400,000 barrels of oil. Biomass contains little sulfur and nitrogen, thus minimizing SO2 and NOx emissions

SUMMARY OF TECHNICAL PROGRESS

After nineteen months PureVision has successfully completed the Inventions and Innovations (I&I) biomass fractionation scale-up program. The initial goal of the I&I program was to develop the design criteria to build a small continuous biomass fractionation apparatus utilizing a twin-screw extruder with a novel screw configuration to create multiple reaction zones, separated by dynamic plugs that support the continuous counter-flow of liquids and solids at elevated pressure. The eventual outcome of the I&I program far exceeded initial expectations by not only developing the design criteria for a continuous process development unit (PDU), but being able to procure, build, shakedown and perform initial testing of the PDU.

A number of significant challenges to overcome in going from a batch process to a continuous process are as follows: 1. Successfully feed biomass into the PDU while maintaining adequate processing pressures within the PDU. 2. Create dynamic plugs within the PDU in order to create zones able to maintain pressure under steady state processing conditions. 3. Perform true counterflow, with solids going one direction and liquids going the other direction inside the PDU. 4. Extract solids at the downstream end of the PDU after liquid counterflow washing. 5. Extract and characterize liquids after counterflow washing of the biomass inside the PDU without plugging the liquid discharges ports. 6. Perform steam explosion on the cellulose product utilizing two solid discharge valves that will be able to maintain pressures inside the PDU while successfully discharging solids at the downstream end of the PDU. 7. Perform steady state counterflow biomass fractionation at desired processing temperatures and pressures, and 8. Produce a purified cellulose product that is highly reactive and amenable to undergo enzymatic hydrolysis.

During the last six months and most significantly during the recent month of March 2004, development efforts took place at Western Research Institute (WRI) under the direction of PureVision's Chief Technology Officer Dick Wingerson. Major processing challenges were overcome to include numbers 1 through 4 listed above. The most significant processing challenge (number 5 above) had been overcome during the last two weeks of March. This latest development has now provided the development team with very important data that has led to an updated design and configuration to the barrels that will house the liquid discharge ports for the PDU and future scaled-up versions.

PureVision ran out of money and time to run the PDU at optimum operating pressures and temperatures to produce a purified cellulose product to be used in initial hydrolysis testing, although hydrolysis testing was conducted on material from batch processing. This situation made it impossible to generate meaningful wash liquor streams for analysis and to operate and test the solids discharge valves that were had designed and purchased for the PDU.

PureVision believes there to be no unresolved technical barriers with the PureVision biomass conversion technology. The most questionable features (such as feedstock injection, the formation of pressure retaining dynamic plugs to create multiple reaction chambers, the counter-flow of solids and liquids, and the separation of liquids with fines from solids at the liquid discharge ports) have been demonstrated in the PDU. Apparatus for releasing product cellulose in a steam explosion has been fabricated for the PDU but has not been tested or optimized. The remaining major technical challenges are expected to be those associated with scale-up. As summarized by Dick Wingerson, the scientist who conceived this unique technology, "At this point, there appear to be no showstoppers."

SUMMARY OF PLANNED WORK

Completion and submittal of the final report is expected by 6/30/04.

PROJECT ANALYSIS

As stated, the project exceeded goals by actually building and running the PDU. PureVision received two awards from the Biomass Program and the ITP Forest Products Program to further develop this technology with a variety of biomass feedstocks and more sophisticated PDUs.

ACTION REQUIRED BY DOE HEADQUARTERS

No action is required from DOE Headquarters at this time.

STATEMENT OF WORK

DE-FG36-02GO12059

PureVision Technology, Inc.

Completing Pre-Pilot Tasks to Scale Up Biomass Fractionation Pretreatment Apparatus from Batch to Continuous Process

Detailed Task List

Task 1.

Goal 1 is to operate and collect data on a continuous biomass processing apparatus at Coperion, with the following objectives:

a) Identify potential processing problem areas and focus on providing remedies.
b) Design a continuous reactor with processing flexibility, capable of processing diverse biomass inputs. This includes having many input and output ports that can be easily activated or deactivated.
c) To determine all the necessary elements, procedures and costs in retrofitting off-the-shelf plastic extrusion equipment into biomass processing and conversion equipment.
d) Coperion to retrofit, test and collect data on their pilot testing equipment.
e) Demonstrate, using Coperion's pilot testing equipment, the ability to process corn stover into three fractions as previously detailed.
f) Gather supporting data to determine the go, no-go decision of retrofitting and utilizing the twin screw extrusion for PureVision's biomass conversion Invention.
g) Produce data on flow rates, pH adjustments, processing temperatures, reagent usage, etc., building on the work from WRI.
h) Obtain a bid from Coperion on purchasing the retrofitted extrusion pilot equipment, leasing the pilot equipment, or entering into a lease with an option to buy the pilot equipment.
i) Investigate scaling capabilities of retrofitted, off-the-shelf Coperion equipment.

Task 2.

Goals 2 and 3 are to design, build, run and collect data on a liquid-separation and purification apparatus from the hemi-sugar-rich wash liquor stream (Goal 2) and the lignin-rich wash liquor stream (Goal 3) generated from the processing wash stream fractions detailed above in 4.1. and 4.2 (1). LSU will perform liquid separation and purification steps utilizing their bench scale and ultimately their pilot equipment that is situated at the Louisiana State University (LSU) facilities. Objectives for goals 2 and 3 are as follows:

a) Perform assays and formal characterizations on wash liquor streams.
b) Establish targets of separating and purifying hemi and lignin products in wash liquor streams.
c) Identify potential wash liquor processing problem areas and focus on providing remedies to these areas first.
d) Determine ability to produce purified product streams from the wash liquor streams.
e) Determine energy and utility requirements associated with separating and purifying product streams.
f) Design and engineer liquid-separation pilot equipment to also be skid mounted and integrated with the extrusion biomass processing equipment.
g) Determine costs to purchase liquid separation and purification equipment.

Task 3.

WRI will determine the Btu value of the purified lignin stream and its co-firing with fossil fuel.

Task 4.

The goal of Task 4 is to engage the University of Colorado (CU) and Colorado State University (CSU) to perform enzymatic hydrolysis tests and corresponding assays on the purified cellulose products being generated from the biomass processing described above.

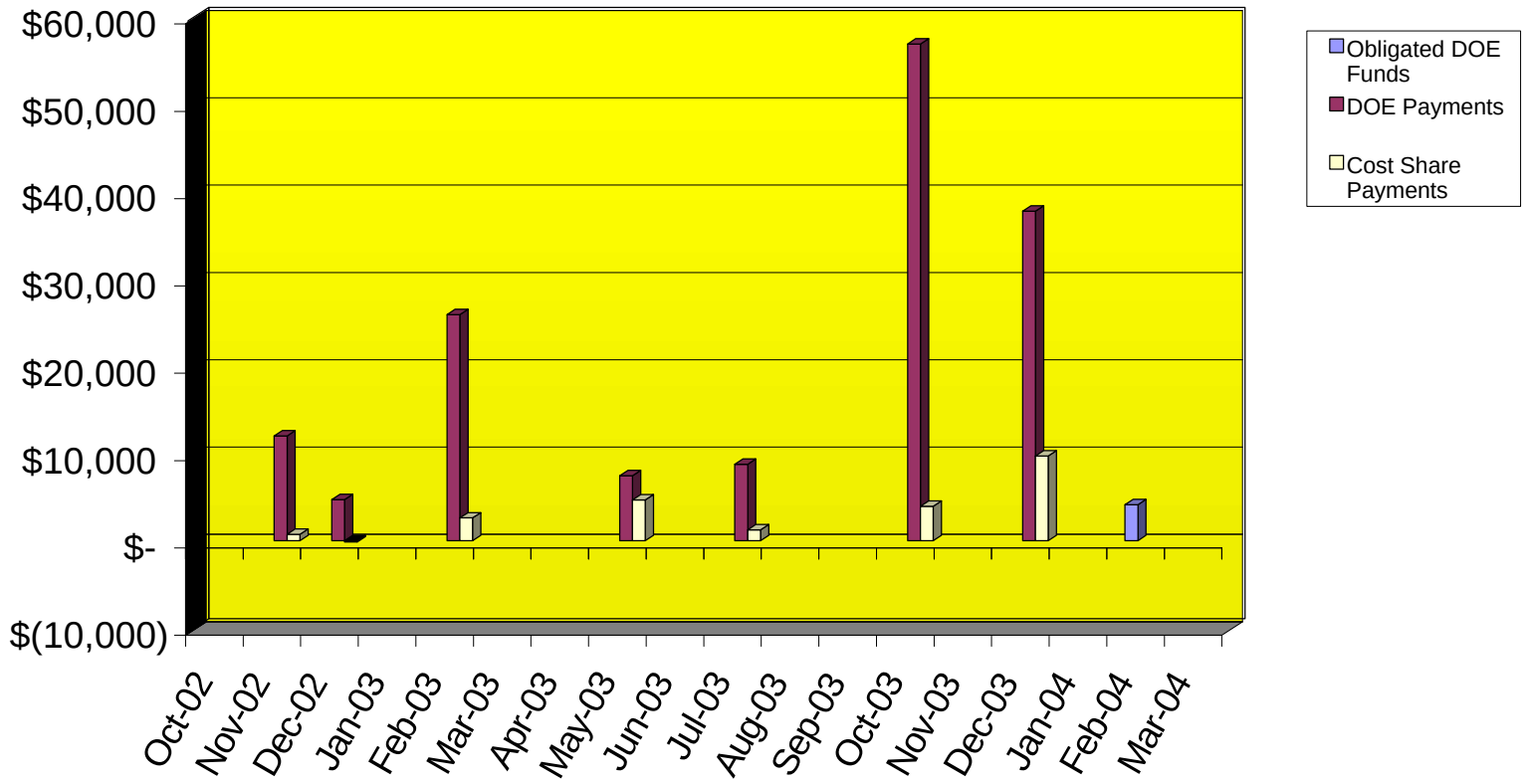
Task 5.

The goal of Task 5 is to engage Hazen to complete preliminary design and costing for assembling and shaking down the proposed pretreatment pilot plant.

Project Cost Performance in DOE Dollars for Fiscal Year 2003

DE-FG36-02GO12059 **PureVision Technology, Inc.**

Completing Pre-Pilot Tasks to Scale Up Biomass Fractionation Pretreatment Apparatus from Batch to Continuous Process



	Oct-02	Nov-02	Dec-02	Jan-03	Feb-03	Mar-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03
Obligated DOE Funds	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
DOE Payment	$0	$12,004	$4,694	$0	$25,892	$0	$0	$7,453	$0	$8,766	$0	$0
Cost Share Payment	$0	$723	-$145	$0	$2,608	$0	$0	$4,679	$0	$1,228	$0	$0

	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04	PFY*	Cumulative
Obligated DOE Funds	$0	$0	$0	$0	$4,119	$0	$195,881	$200,000
DOE Payment	$56,899	$0	$37,747	$0	$0	$0	$0	$153,456
Cost Share Payment	$3,954	$0	$9,708	$0	$0	$0	$0	$22,756

Approved DOE Budget:	$200,000
Approved Cost Share Budget:	$33,799
Total Project Budget:	$233,799

* Prior Fiscal Years

PureVision Technology, Inc. - 02GO12059

ID	Task Name	Start	Finish
1	Retrofit, operate, and collect data on continuous biomass	Mon 8/19/02	Thu 6/5/03
2	Collect data on liquid-separation/purifica from hemi-sugar wash	Wed 3/5/03	Tue 9/30/03
3	Collect data on the lignin-rich wash liquorstream	Wed 4/30/03	Tue 9/30/03
4	Energy Assays and Evaluations	Wed 10/1/03	Thu 1/1/04
5	Perform enzymatic hydrolysis assays on cellulose	Fri 10/31/03	Fri 1/30/04
6	Complete preliminary design/costing of pretreatment pilot plant	Fri 12/5/03	Thu 2/5/04
7	Project management and reporting	Mon 8/19/02	Wed 2/18/04